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REVIEW OF THE EELPOUT GENUS *PACHYCARA* ZUGMAYER, 1911 (TELEOSTEI: ZOARCIDAE), WITH DESCRIPTIONS OF SIX NEW SPECIES

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ABSTRACT: The eelpout genus *Pachycara* Zugmayer, 1911 is revised to include 12 species, 6 of which are reported here as new: *P. shcherbachevi* from the Indian Ocean; *P. sulkai* and *P. crossacanthum* from the Atlantic; and *P. mesoporum, P. pammelas,* and *P. rimae* from the Pacific. *Pachycara* is a primitive lycodine eelpout genus characterized by its large body size, small head pores, lack of mental crests, and low parasphenoid wing. It is most closely related to *Lycodes* Reinhardt, 1832, and *Thermarces* Rosenblatt and Cohen, 1986. The species of *Pachycara* are characterized by their lateral line patterns, variably present or absent pelvic fins, counts of the axial skeleton, gill raker morphology, head pore patterns, and branchiostegal ray number. The genus is distributed in the eastern Pacific, Antarctic, Atlantic and Indian oceans from the upper continental slope to the abyss (200–4,780 m).

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INTRODUCTION

The eelpout genus *Pachycara* was erected by Zugmayer (1911a, b) for a species known from a single specimen taken in the abyssal North Atlantic. Anderson (1988a) considered the Antarctic genus *Austrolycichthys* Regan, 1913 a junior synonym of *Pachycara,* broadening the diagnosis chiefly by rejecting the presence or absence of pelvic fins as a generic character in eelpouts (see also Anderson 1988b). Anderson and Peden (1988) reported the genus from the North Pacific for the first time, further broadening its limits, and described two new species. They cited my unpublished dissertation (Anderson 1984) as a source of information on the genus. This paper is an update of that study, revised to include 12 species, six of which are new.

Considerable taxonomic confusion exists in the literature on eelpouts, especially for the rare deep-sea species. As was found earlier (Anderson 1982a), comparison of recently collected specimens of *Pachycara* with older, published material was difficult because of a lack of, or poor state of, types and the use of non-diagnostic characters by previous authors. As a contribution to the clarification of the systematics of *Pachycara,* I provide descriptions and/or diagnoses for all species, list synonymies, provide a key, distributional maps and illustrations to facilitate identification, and compare *Pachycara* to its putative sister genera.

Prior to the postwar rejuvenation of deep-sea exploration, specimens here referred to *Pachycara* were few in collections, and, in fact, consisted only of the types of *P. bulbiceps* (Garman,

1899) (=*P. obesa* Zugmayer, 1911), *P. suspectum* (Garman, 1899), *P. crassiceps* (Roule, 1916), and about 60 specimens of *P. brachycephalum* (Pappenheim, 1912). The more important recent collections of deep-sea fishes that resulted in the capture of *Pachycara* specimens are briefly discussed below.

Specimens from the Pacific Ocean were first taken during the round-the-world expedition of the Danish ship GALATHEA which collected the rare *P. suspectum* in the Gulf of Panama in 1952. This expedition had in the previous year collected the holotype of *P. shcherbachevi* in the Bay of Bengal. The bulk of the North Pacific species were taken by free vehicle set line traps by personnel of the Scripps Institution of Oceanography off Mexico and southern California, by bottom trawls operated from ships of Oregon State University, and by Canadian experimental sablefish (*Anoplopoma fimbria*) traps off the Queen Charlotte Islands (summarized in Anderson and Peden 1988). Specimens from the southeastern Pacific have come from operations of DSV ALVIN in the Galapagos Rift Zone (Cohen and Haedrich 1983), Chilean fisheries reconnaissance, supplied to the author by Ismael Kong, University of Antofagasta, and deep-sea bottom trawls by the ship ANTON BRUUN during the National Science Foundation's Southeastern Pacific Biological Oceanographic Program (SEPBOP). Explorations in the Atlantic Ocean began with the capture of the type species, *P. obesa* (=*P. bulbiceps*) by the expeditions of Prince Albert I of Monaco in the Bay of Biscay (Zugmayer 1911a, b). Subsequently, other eastern Atlantic material has come from expeditions of the Institute of Oceanographic Sciences, U.K. (Merrett and Marshall 1981), the BENGUELA VII expedition of the Instituto de Investigaciones Pesqueras de Barcelona (now Instituto de Ciencias del Mar), fish trapping cruises of the Office de la Recherche Scientifique et Technique Outre-Mer, Dakar, Senegal, exploratory fisheries cruises of the USSR (Golovan' 1978), and similar cruises by the South African ship AFRICANA around the Cape of Good Hope. Specimens of *Pachycara* from the northwestern Atlantic are relatively few and were taken by bottom trawls in the Middle Atlantic Bight (Musick 1979; Haedrich et al. 1980), the Caribbean Sea (Anderson et al. 1986), by bottom traps around Puerto Rico, supplied to the author by Dannie A. Hensley, University of Puerto Rico, and from operations of DSV ALVIN in the Gulf of Mexico (Paull et al. 1984).

Methods and Materials

Measurements were made with dial calipers or ocular micrometer to the nearest 0.1 mm. Osteological observations were made on cleared and stained specimens (Dingerkus and Uhler 1977) and drawings made with the aid of a camera lucida. Definitions of characters and measurements follow those of Anderson (1982a, 1984). Institutional abbreviations are as listed in Leviton et al. (1985), or as emended by Leviton and Gibbs (1988).

This review is based on 249 specimens, 76–597 mm standard length (SL), housed in 21 museum collections in 12 countries (listed by abbreviation in each account; measurements of specimens in SL). All type specimens were examined except the holotype of *Lycenchelys crassiceps* Roule, 1916, thought to be lost. A lectotype of *Lycodes brachycephalus* Pappenheim, 1912, is selected. Full accounts and illustrations are provided for all species except those recently reviewed (*P. brachycephalum* [see Anderson 1988a], *P. bulbiceps, P. gymninium, P. lepinium,* and *P. suspectum* [see Anderson and Peden 1988]), but expanded diagnoses for these species are provided which include other, important characters, for ease of reference under one cover. The osteological section of the description of the genus is intentionally brief, and the reader should consult Anderson (1982a) for a more thorough account of a generalized zoarcid (which includes *Pachycara*).

Species accounts are presented alphabetically by ocean basin in the following order: Atlantic, Indian, Pacific, and Antarctic.

Abbreviations for bone names used in the text figures are as follows:

act—actinosts
ang—anguloarticular
boc—basioccipital
br r—branchiostegal ray
cerhy—ceratohyal
cl—cleithrum
cor—coracoid
den—dentary
ect—ectopterygoid
epihy—epihyal

epo—epioccipital (epiotic)
exo—exoccipital
fr—frontal
hyom—hyomandibula
hyphy—hypohyals
inop—interopercle
inthy—interhyal
lat eth—lateral ethmoid
mes—mesethmoid
met—metapterygoid
op—opercle
pal—palatine
par—parietal
pas—parasphenoid
pcl—postcleithrum
pel—pelvic (basipterygium)
pmx—premaxilla
pop—preopercle
ptem—posttemporal
pto—pterotic
pts—pterosphenoid
quad—quadrate
scap—scapula
sop—subopercle
sph—sphenotic
supcl—supracleithrum
urhy—urohyal

Pachycara Zugmayer, 1911

Pachycara Zugmayer, 1911a:12 (original description; expanded in Zugmayer, 1911b:134–136, pl. VI, fig. 6. Type species: *Pachycara obesa* Zugmayer, 1911 (=*Maynea bulbiceps* Garman, 1899), by monotypy.
Austrolycichthys Regan, 1913:244–245, fig. 2 (type species: *Lycodes brachycephalus* Pappenheim, 1912, by subsequent designation of Jordan, 1920:550).
Pachycarichthys Whitley, 1931:334 (improper emendation).
Pachychara (lapsus calami). Fowler, 1936:1056, fig. 437; Andriashev, 1986:170, text fig.

Diagnosis.—Body robust, tail short; skin firm; mental crests (cartilaginous ridges on dentary) absent; parasphenoid wing not extending above mid-height of trigeminofacialis foramen; palatopterygoid (palatal) arch well developed, with ectopterygoid and mesopterygoid broadly articulating with quadrate; cephalic lateralis pores few, small, rounded; precaudal vertebrae 21–32; suborbital bones 6–8; pelvic fins present or absent, their presence individually variable in two species; scales, body lateral line, vomerine and palatine teeth, pseudobranch (except in one species), and pyloric caeca present.

Description.—Head large, ovoid, snout generally bluntly rounded, never dorsoventrally depressed in adults; young juveniles with somewhat depressed heads, but snout not as long and tapering as lycenchelyine (Anderson 1984) genera. Largest males with wider head than in females owing to greater development of adductor mandibulae (in those species with sample size large enough to test statistically). Body elongate, robust, subcircular in cross-section, its greatest depth midway between pectoral base and anus; body height at anal fin origin 7.7–16.9% SL in specimens over 160 mm SL. Tail high, increasingly laterally compressed posteriad. Skin firm, not gelatinous, covering all fins. Scales minute, cycloid, imbedded, covering body usually including abdomen (except in smallest specimens and *P. rimae*), bases of vertical fins, pectoral base and pectoral axil. Complete mediolateral and ventral (Andriashev 1954, fig. 142) lateral line(s) developed as single row of superficial neuromasts ("free lateralis organs"; Springer and Freihofer 1976), their origins variable and usually species specific. Eye large and ovoid in young, often relatively small and rounded in adults, often entering dorsal profile of head. Nostril single, tubular, at snout tip, nasal tube not reaching upper lip except in some young. Pectoral fin large, of 14–19 rays, middle rays longest in large specimens, lowermost rays thickened, slightly exserted at tips. Pectoral base low on body, its origin just below midline, insertion on abdomen. Gill slit extending ventrally to lower margin of pectoral base or below. Ovary single. Pseudobranch filaments 2–7 (absent in *P. rimae*). Two nublike pyloric caeca, usually better defined in young. Stomach and intestines pale. Peritoneum black. Reproductive mode unknown, probably oviparous.

Mouth terminal or subterminal, lips fleshy but not thickened. Upper lip free across snout, lower lip adnate at dentary symphysis. Oral valve (palatal membrane) moderately developed, usually reaching anterior margin of vomer, but often constricted at sides except in very small specimens.

Cephalic lateralis pores small, rounded, relatively few. Six (usually; eight in *P. crassiceps*) suborbital bones from which arise 5–7 pores. One to four postorbital pores present, their number, like those of suborbitals, individually variable within a species. Two nasal (anterior supraor-

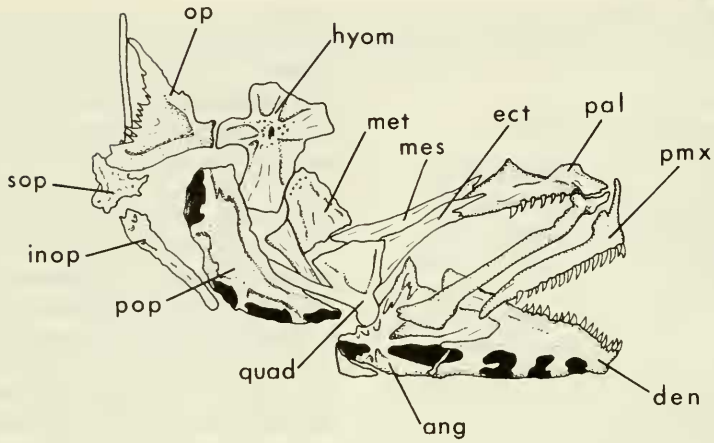

FIGURE 1. Jaws, suspensorium, and opercular bones of *Pachycara bulbiceps*, BMNH 1981.6.16:15, 332 mm SL; right lateral view.

bital) pores present at snout tip arising from foramina in anterior and posterior ends of nasal bone. Interorbital pore(s) absent. Occipital pores absent except in *P. mesoporum* and in two of six specimens of *P. crossacanthum*. Preopercular and mandibular canals joined; preoperculomandibular pores and bone foramina system in plesiomorphic state for family (and no variation noted), with four pores emanating from dentary, one from anguloarticular, and three from preopercle (Fig. 1). Head speckled with small, white superficial neuromasts, particularly on nape and cheeks; no pattern to these discernible.

Neurocranium well ossified, somewhat boxlike (Fig. 2). Lateral ethmoid broad, not strongly decurved, but deeply sculptured at surface for attachment of palatine ligaments. Anterior, cupshaped section of mesethmoid broad, deep. Parasphenoid wing low, not reaching mid-height of trigeminofacialis foramen, broadly articulating with frontal and pterosphenoid. Pterosphenoid almost completely forming anterior border of trigeminofacialis foramen. Frontals unfused, with deep, open channel anteriorly passing supraorbital lateralis canal. Sphenotic and parietal separated by frontal and pterotic. Lateral protuberance for attachment of levator arcus palatini muscle a weak ridge. Parietals separated from midline by supraoccipital, with no channel through posterior margin bracing supratemporal commissure (which is incomplete or absent in all but two species). Supraoccipital large, anterior ramus extending well under frontals, mesial crest low; supraoccipital narrowly contacting exoccipital posteriorly. Prootic and sphenotic articulating dorsally forming hyomandibular condyle. Hyomandibular foramen well separated from condyle (Fig. 2A). Prootic also articulating dor-

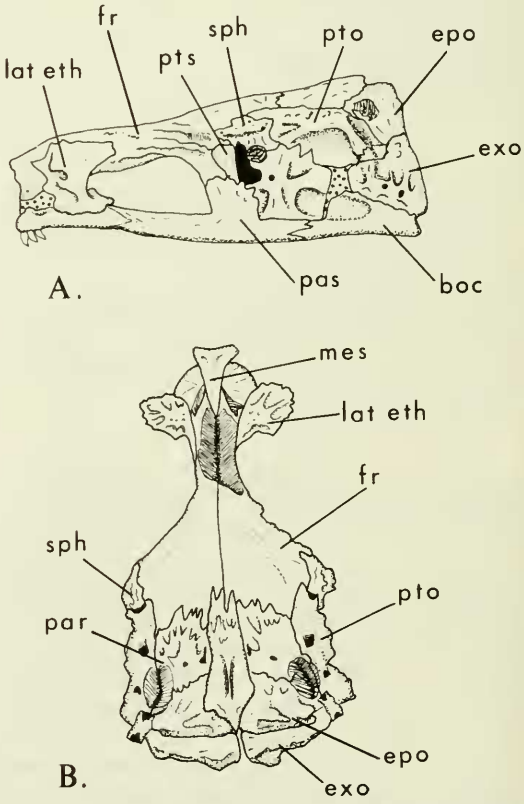

FIGURE 2. Neurocranium of *Pachycara gymninium*, BCPM 980-100, 281 mm SL: (A) left lateral view; (B) dorsal view.

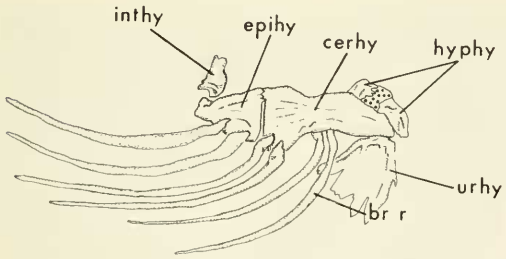

FIGURE 3. Right hyoid bar of *Pachycara gymninium*, BCPM 980-100, 281 mm SL; lateral view.

sally with pterotic and intercalar, which form a ridge extending onto exoccipital. Single pair of small, barrel-like lateral extrascapulars present. Foramina passing ninth (glossopharyngeal) and tenth (vagus) cranial nerves located on low, lateral ridge well away from margins of exoccipital.

Teeth present on jaws (absent on maxilla), vomer, palatine and pharyngeal bones. Palatopterygoid (palatal) arch well developed, ectopterygoid and mesopterygoid broadly overlapping anterior and dorsal margins of quadrate (Fig. 1). Hyomandibular posterior ramus not elongated. Opercle (posteriorly) and subopercle poorly ossified. Metapterygoid relatively large and thick.

Most or all of ceratohyal–epihyal juncture smooth, space between bones cartilage-filled; bone weakly interdigitating dorsally in large specimens of one observed species (Fig. 3). Hypohyals separated by wide, cartilage-filled space. Interhyal ventral surface with concave fossa; dorsal tip not greatly sculptured. Six branchiostegal rays present (except in *P. rimae*), with four articulating with ceratohyal and two with epihyal. Urohyal large and broad, with well developed fossae dorsally for attachment of sternohyoideus muscle.

Ceratobranchial five (lower pharyngeals) dentigerous, unfused. Three pairs of ossified infrapharyngobranchials (upper pharyngeals), associated with gill arches 2–4. Three ossified basibranchials; fourth an irregular cartilaginous pad. Uncinate processes on epibranchials three and four only. Gill rakers present on epibranchials, ceratobranchials, and usually one or two on hypobranchials, numbering 10–21 on first arch.

Posttemporal ventral ramus weak or absent (Fig. 4). Supracleithrum with thin, poorly ossified posterior lamina; median ridge well developed. Scapular foramen enclosed by bone; scapula with well developed posterior strut. Four actinosts present bearing all pectoral rays but dorsalmost 2–3 (borne by scapular strut). Pelvic fins absent (*P. bulbiceps*), present (10 species), or variably present and absent (*P. mesoporum* and *P. sulaki*), with three (rarely two) soft rays. Single, needlelike postcleithrum present. Cleithrum with deep dorsal and ventral grooves for muscle attachments.

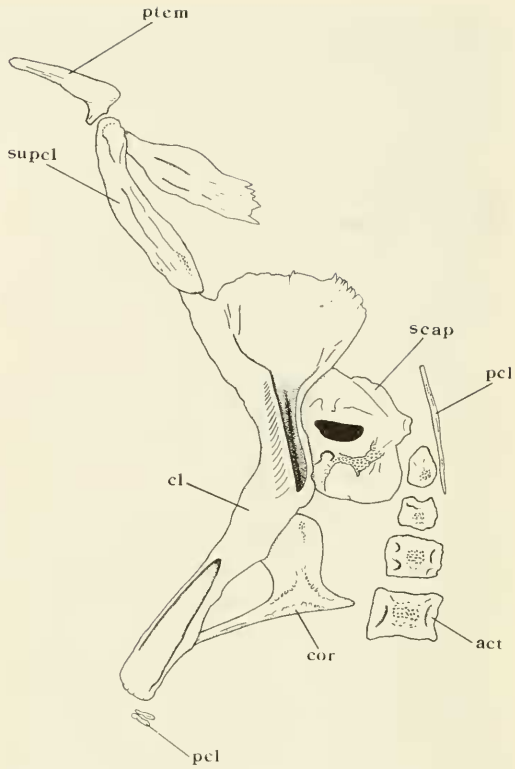

FIGURE 4. Left pectoral girdle of *Pachycara bulbiceps*, CAS 61220, 445 mm SL; lateral view. Pelvic bones greatly reduced in size in this species.

Vertebrae symmetrical. Epipleural ribs on vertebrae 1–21 or 22. Pleural ribs on third to ultimate precaudal vertebrae. Dorsal fin origin associated with vertebrae 2–8, with no free dorsal pterygiophores. First, or first and second, dorsal element a "flexible spine" (unsegmented and unbranched, but bilaterally divided at base); occasionally branched at tip, but this may be a preservation artifact. Last dorsal ray associated with second through fifth (usually fourth) preural vertebrae. Anal fin origin associated with antepenultimate to ultimate precaudal vertebrae, with 1–9 anal pterygiophores (all bearing soft rays)

inserted anterior to haemal spine of first caudal vertebrae. Last anal ray associated with second (rarely third) preural vertebrae. Caudal fin with 1–3 epural and 3–6 upper and lower hypural rays, totaling 8–12 rays.

Comparative Remarks.—Recently, Arnulf et al. (1987) elaborated on the osteology and relationships of *Thermarces* Rosenblatt and Cohen, 1986, thought to be derived from *Pachycara* by the latter authors. *Thermarces* was diagnosed by Rosenblatt and Cohen, in part, on the basis of four characters shown by Arnulf et al. (1987) to have different states than those originally described (those of original description given first): (1) one or two suborbital ossifications vs. six; (2) pectoral radials unossified vs. ossified; (3) two pairs of infrapharyngobranchials vs. three; and (4) postcleithrum absent vs. present. The specimen of *Thermarces cerberus* (SIO 82-46) studied by Rosenblatt and Cohen was poorly ossified and I have observed, on subsequent restaining, a postcleithrum, six suborbital bones, four pectoral radials, and a cartilaginous third pharyngeal tooth plate. These structures, although bony, picked up very little or no alizarin-red stain, however. The skeletons of many deep-sea zoarcids are relatively unossified (Anderson and Hubbs 1981) and endochondral bone may not fully ossify in individuals of some species living in possibly environmentally stressful habitats. Stresses to normal calcium metabolism in the hydrothermal vent habitat of *Thermarces* may include high dissolved sulphide and metal ion levels (J. M. Edmonds, Massachusetts Institute of Technology, pers. comm.), making alizarin staining difficult (Anderson 1984). This seems to have been the case with the specimen cleared and stained by Rosenblatt and Cohen (1986) for illustration.

On the basis of the detailed osteology presented by Arnulf et al. (1987) and my studies, *Thermarces* does appear to be derived from, and very close to, *Pachycara,* although Arnulf et al. suggested *Thermarces* might be placed in a new subfamily someday. However, *Thermarces* is separable from *Pachycara* by only four characters: (1) pelvic bone absent; (2) scales absent; (3) lateral line absent; (4) flesh gelatinous. Although Arnulf et al. presented a detailed osteological description of *Thermarces,* their discussion on relationships and characters is flawed. For example, their table 1 is a very limited assemblage of essentially non-diagnostic characters of higher groups, some of which are redundant. Their subfamily "Brotulinae" refers to the Parabrotulidae (Nielsen 1973, 1986; Anderson 1986). Subfamily Neozoarcinae was placed in Stichaeidae by Anderson (1984). *Melanostigma* was shown not to possess a basisphenoid bone by Anderson and Hubbs (1981). The attribution and interpretation of many characters of zoarcids by Arnulf et al. are mostly incorrect and a detailed discussion of these and an osteological analysis will be presented elsewhere.

Key to Species of *Pachycara*

1A. Branchiostegal rays six; pseudobranch present 2

1B. Branchiostegal rays four or five; pseudobranch absent .. *Pachycara rimae* n. sp. Galapagos Rift Zone

2A. Occipital (supratemporal) pores absent (rarely present in *P. crossacanthum*; precaudal vertebrae 26–28 3

2B. Single, mesial occipital pore present; precaudal vertebrae 24–26 ..... *Pachycara mesoporum* n. sp. Peru and Chile

3A. Lateral line with mediolateral and ventral branches*; precaudal vertebrae 23–32; dorsal fin origin associated with vertebrae 3–8; anal fin origin associated with vertebrae 23–31 4

3B. Lateral line of ventral branch only; precaudal vertebrae 21–23; dorsal fin origin associated with vertebrae 2–3; anal fin origin associated with vertebrae 20–22 ..... *Pachycara suspectum* (Garman, 1899) Eastern Tropical Pacific

4A. Dorsal fin origin associated with vertebrae 3–7; precaudal vertebrae 23–30; head length 11.8–19.9% SL 5

4B. Dorsal fin origin associated with vertebra 8; precaudal vertebrae 32; head length 11.4% SL ..... *Pachycara shcherbachevi* n. sp. Indian Ocean

5A. Gill rakers on lower limb (ceratobranchial) of first arch blunt, triangular 6

* Lateral line condition unknown in *P. shcherbachevi* n. sp.

FIGURE 5. Distribution of selected *Pachycara* species. Circles: *P. bulbiceps*; squares: *P. crassiceps*; hexagons: *P. crossacanthum*; triangles: *P. sulaki*; star: *P. shcherbachevi*.

5B. Gill rakers on lower limb of first arch bi- or tricuspid ..... *Pachycara crossacanthum* n. sp. Eastern Tropical Atlantic

6A. Origin of ventral branch of lateral line just posterior to last postorbital pore 7

6B. Origin of ventral branch of lateral line on or behind vertical through posterior third of pectoral fin ..... *Pachycara sulaki* n. sp. Western Tropical Atlantic

7A. Pelvic fins present 8

7B. Pelvic fins absent ..... *Pachycara bulbiceps* (Garman, 1899) NE Pacific and N Atlantic

8A. Suborbital pores along ventral ramus (beneath eye) six 9

8B. Suborbital pores beneath eye five ..... *Pachycara brachycephalum* (Pappenheim, 1912) Antarctica

9A. Origin of mediolateral branch of lateral line on or behind vertical through pectoral axil 10

9B. Origin of mediolateral branch of lateral line on nape, just posterodorsal to last postorbital pore ..... *Pachycara pammelas* n. sp. Chile

10A. Precaudal vertebrae 27–31 origin of mediolateral branch of lateral line anterior to vertical through posterior third of pectoral fin 11

10B. Precaudal vertebrae 23–26; origin of mediolateral lateral line at or posterior to vertical through posterior margin of pectoral fin ..... *Pachycara lepinium* Anderson and Peden, 1988 Northeastern Pacific

11A. Total vertebrae 102–109; caudal vertebrae 73–80; D 96–103; A 77–84; pectoral fin length 63.0–70.8% HL ..... *Pachycara gymninium* Anderson and Peden, 1988 Northeastern Pacific

11B. Total vertebrae 111–118; caudal vertebrae 84–88; D 105–112; A 86–92; pectoral fin length 81.6–97.0% HL ..... *Pachycara crassiceps* (Roule, 1916) Eastern Atlantic

Pachycara bulbiceps (Garman, 1899)

(Figs. 1, 4, 5)

Maynea bulbiceps Garman, 1899:140–141, pl. E, fig. 1 (original description. Type locality: Gulf of Panama). McAllister and Rees, 1964:106, 107. Pearcy et al., 1982:387, 399, 400.

Pachycara obesa Zugmayer, 1911a:12; 1911b:134–136, pl. VI, fig. 6 (type locality: Bay of Biscay). Markle and Sedberry,

1978:22–25, fig. 1. Merrett and Marshall, 1981:240. Andriashev, 1973:547. Haedrich and Merrett, 1988:1335, 1338 (as *obesum*).

Pachychara obesa Zugmayer (lapsus calami). Fowler, 1936: 1056, fig. 437. Andriashev, 1986:1149, text fig.

Pachycara bulbiceps (Garman). Anderson and Peden, 1988: 84–88, figs. 1–3.

MATERIAL EXAMINED.—See Anderson and Peden (1988:84–85).

DIAGNOSIS.—Pelvic fins absent; mediolateral lateral line originating posterior to pectoral fin margin; scales absent on nape; vertebrae 25–31 + 82–91 = 112–119; D 104–114; A 86–97; P_1 16–19; dorsal fin origin associated with vertebrae 4–7; gill rakers 0–4 + 11–15 = 11–19; branchiostegal rays six; suborbital pores 6–7; postorbital pores 1–3; head length 11.8–15.0% SL; pectoral fin length 8.7–12.9% SL.

DISTRIBUTION.—Both sides of the North Atlantic at depths of 2,400–4,780 m and in the northeastern Pacific from the Queen Charlotte Islands, Canada, to the Gulf of Panama at depths of 2,601–4,000 m (Fig. 5).

Pachycara crassiceps (Roule, 1916)

(Figs. 5, 6)

Lycenchelys crassiceps Roule, 1916:16 (original description. Type locality: Bay of Biscay; based on two syntypes apparently lost).

Lycodes macrops (non Günther 1880). Vaillant, 1888:306–309.

Lycodes mucosus (non Richardson 1855). Vaillant, 1888:311–312.

Lycenchelys crassiceps. Roule, 1919:64–66, pl. V, fig. 1. Merrett and Marshall, 1981:240.

Lycodes sp. Golovan', 1974:289.

Lycodes atlanticus (non Jensen 1902). Golovan', 1978:226.

Lycodes crassiceps. Andriashev, 1986:1137, text fig.

MATERIAL EXAMINED.—BMNH 1981.6.23:3 (448 mm); Porcupine Sea Bight, SW of Ireland (51°14.7′N, 13°16.3′W); CHALLENGER sta. 50509; trawl, 1,490–1,523 m; 3 June 1979. ZIN 45347 (415 mm); off Cabo Barbas, Western (Spanish) Sahara (22°20′N, 17°30′W); ZVEZDA KRYMA sta. 260; trawl, 1,540–1,620 m; 16 Feb. 1973. BMNH 1981.6.23:1, 2 (432–518 mm); off Cap Blanc, Mauritania (20°09.1′N, 18°08.8′W); DISCOVERY sta. 9133-7; trawl, 2,130–2,191 m; 26 Nov. 1976. CAS 55587 (337 mm); off Senegal (13°12.5′N, 17°43.4′W); L. AMARO; trap, 1,300 m; 10 Feb. 1983. ZIN 45348 (509 mm); off Cape Fria, Namibia (18°26′S, 14°06′E); EVRIKA; trawl, 1,100–1,125 m; 22 Dec. 1975. IIPB 168/1985 (513 mm); off Namibia (23°05′S, 12°41′E); BENGUELA VII sta. 2; trawl, 652 m; 9 Aug. 1984. PEM 13784 (395 mm); off Cape of Good Hope, South Africa (33°40.0′S, 17°25.8′E); AFRICANA cruise 060, sta. A6999-01-04B; trawl, 923 m; 5 Mar. 1988. SAM uncat. (396 mm) off Cape of Good Hope (34°54.9′S, 18°12.1′E); AFRICANA cruise 060, sta. A7038-16-04B; trawl, 917 m; 14 Mar. 1988. SAM 31601 (189 mm); off Cape of Good Hope (33°37.5′S, 17°24.5′E); AFRICANA cruise 060, sta. A7002-06-03B; trawl, 668 m; 8 Mar. 1988. RUSI 28210 (380 mm); off Cape of Good Hope (34°25.6′S, 17°41.2′E); AFRICANA sta. A4310; trawl, 760 m; 7 July 1986.

COUNTS AND MEASUREMENTS.—Vertebrae 27–30 + 84–90 = 111–118; D 105–112; A 86–94; C 10–12; P_1 17–19; P_2 3; vomerine teeth 6–8; palatine teeth 8–17; gill rakers 3 + 12–13; branchiostegal rays six; pseudobranch filaments 4–5. Following measurements in percent SL: head length 12.6–14.5; head width 8.0–10.3; pectoral fin length 10.7–13.3; predorsal length 17.3–21.6; preanal length 38.1–43.7; body height 10.7–13.6; gill slit length 5.5–7.4; caudal fin length 2.3–4.6. Following measurements in percent HL: head width 59.4–70.7; upper jaw length 38.7–45.4; pectoral fin length 81.6–97.0; snout length 17.4–23.4; eye diameter 17.3–20.8; gill slit length 40.4–50.7; interorbital width 8.5–11.4; interpupillary width 25.4–33.3; pelvic fin length 9.9–18.6 Pectoral base/length ratio 32.8–44.3.

DIAGNOSIS.—Pelvic fins present; mediolateral lateral line originating above pectoral fin just posterior to pectoral base; scales present on nape; vertebrae 27–30 + 84–90 = 111–118; gill rakers 15–21; pectoral fin length 81.6–97.0% HL.

DESCRIPTION.—Head ovoid, dorsal profile of snout more steeply sloping in large adults than juveniles. Scales extending anteriorly onto nape to about two eye diameters behind posterior margin of eye in large specimens; scales present on abdomen to isthmus, pectoral base and axil, and extending onto pectoral fin up to about half its length; scales present on unpaired fins almost to their margin. Eye circular, entering dorsal profile of head in large specimens. Gill slit extending to ventral margin of pectoral base. Lobe at dorsal margin of gill slit not formed in some large specimens; weak and rounded in juveniles. Pectoral fin origin at or slightly below body midline, insertion on abdomen; posterior margin of fin wedge-shaped (cf. *Lycodes*), pectoral rays 4–8 longest; ventralmost three or four rays thickened, tips slightly exserted.

Mouth subterminal, slightly oblique, upper jaw extending posteriorly to middle of eye. No epidermal prickles evident on snout or lips. Oral valve reaching anterior edge of vomer and coalesced with lateral margin of plate opposite vomer. Jaw teeth small, conical; dentary with 4–5 irregular rows anteriorly, blending into single posterior row; premaxilla with 3–4 anterior rows, blending into single posterior row. Vomerine teeth in irregular patch, longer and sharper in juveniles

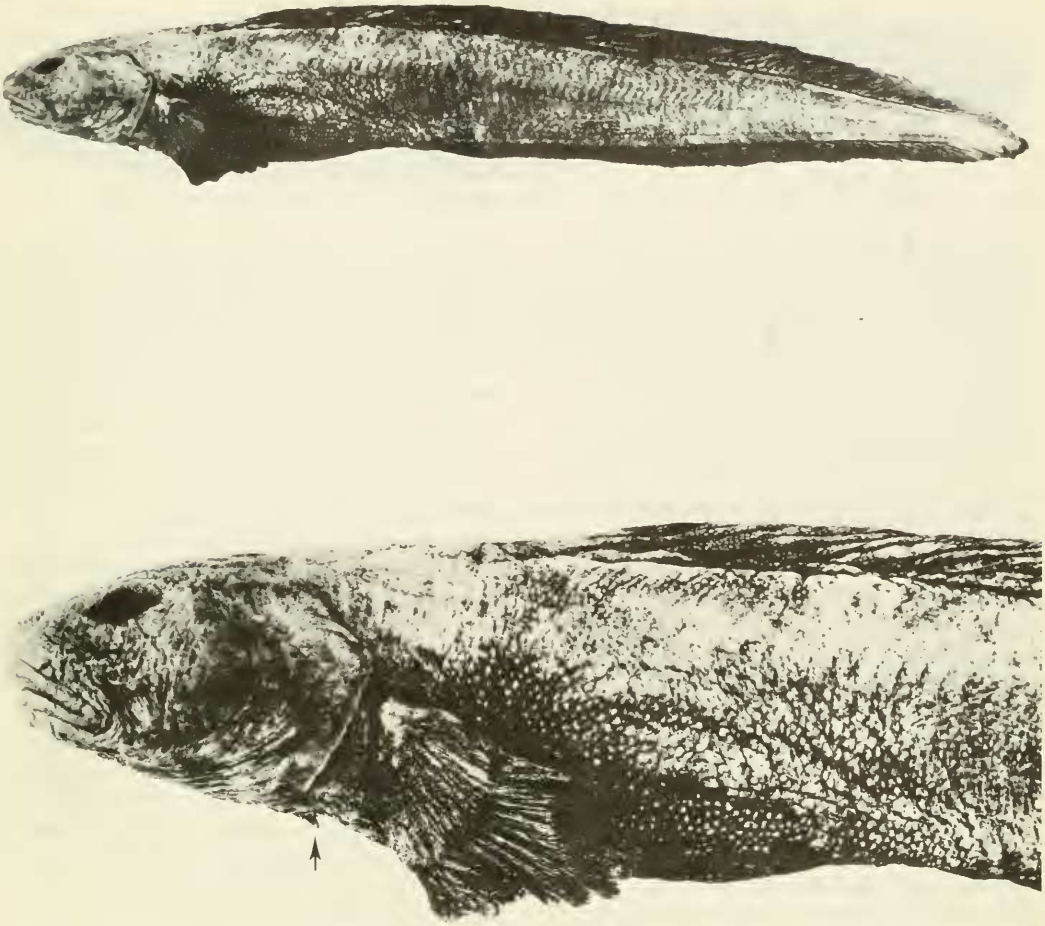

FIGURE 6. *Pachycara crassiceps* (Roule), BMNH 1981.6.23:1–2, 518 m SL, from off Cap Blanc, Mauritania. Arrow indicates pelvic fins.

than adults. Palatine teeth not retrorse, in double row at least anteriorly, in all.

Cephalic lateralis system with two or three postorbital pores (pores one and four, arising from frontal and lateral extrascapular, or pores one, three, and four). Two pairs of anterior supraorbital (nasal) pores, one set mesial to nasal tube, the other posteriorly. Six or seven suborbital pores, six arising from ventral ramus of bone chain and one (absent in three specimens; absent on one side only in one specimen) from ascending ramus behind eye just ventral to first postorbital pore. Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular, and three from preopercle. Interorbital and occipital pores absent. Body lateral line system with mediolateral branch originating above pectoral fin about one eye diameter posterior to pectoral base; ventral branch originating just posterior to fourth postorbital pore; both branches complete to tail tip. Free superficial neuromasts (about 8–10) forming dorsal "lateral line" originating above pectoral base on horizontal through middle of eye and extending posteriorly to vertical through posterior margin of pectoral fin or slightly anteriorly.

Dorsal fin origin associated with vertebrae five or six. Anal fin origin associated with ultimate precaudal vertebrae (numbers 25–30), with 3–5 anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra, last anal ray associated with second preural vertebra. Caudal fin with two epural, 4–5 upper and 4–5 lower

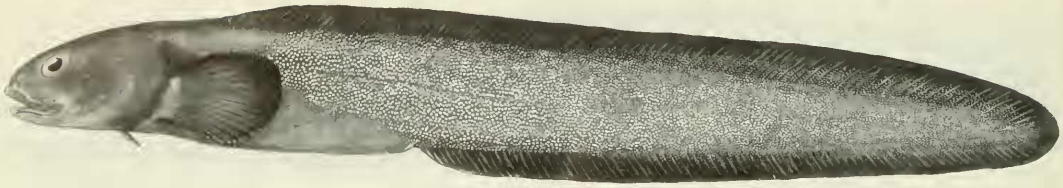

FIGURE 7. *Pachycara crossacanthum* n. sp., CAS 62408, paratype, 227 mm SL, from off Senegal.

hypural rays. Gill rakers, small, dorsalmost on lower limb (ceratobranchial) triangular, sharply pointed, ventralmost blunt; ventralmost four rakers in ZIN 45347 with tricuspid tips. Branchiostegal rays six. Pseudobranch filaments long, simple.

Color uniformly black (adults) or dark chocolate brown (juveniles), in recently preserved material. Eye blue. Abdomen with bluish tinge in juveniles, black in adults. Lining of orobranchial cavity black, lateral regions of palate pale.

DISTRIBUTION.—Known in eastern Atlantic from SW of Ireland to off South Africa on upper and lower continental slopes at depths of 652–2,191 m (Fig. 5).

REMARKS.—This species was originally described from two syntypes, neither of which were found. However, a neotype is not selected here as the syntypes have not been sufficiently searched for, and diagnostic features (counts of the axial skeleton from x-radiography) published in Roule (1919) permit the distinction of *P. crassiceps* from its close congener, *P. crossacanthum* (below). Pectoral fin ray counts in Roule (1919) are, however, undoubtedly erroneous.

Pachycara crossacanthum n. sp.

(Figs. 5, 7, 8)

HOLOTYPE.—CAS 55586 (female, 370 mm); off Senegal (12°58.0′N, 17°41.8′W); L. AMARO sta. Casamance; fish trap, 900 m; B. Seret, 8 Feb. 1983.

PARATYPES.—MNHN 1988-1170 (3; 227–378 mm); collected with holotype. CAS 62408 (female, 227 mm); off Senegal (15°47.8′N, 17°07.1′W); L. AMARO, sta. 6; fish trap, 900 m; D. Gaertner, 29 Mar. 1984. MNHN 1988-1169 (female, 353 mm); off Pointe Banda, Gabon (04°00′S, 10°08′E); NIZERY sta. 14-76; fish trap, 1,050 m; A. Crosnier, 20 May 1976.

COUNTS AND MEASUREMENTS.—Vertebrae 26–28 + 75–79 = 101–107; D 97–103; A 77–83; C 10–12 P_1 17–18; P_2 3; vomerine teeth 5–14; palatine teeth 6–16; gill rakers 3 + 12–13; branchiostegal rays six; pseudobranch filaments 4–5. Following measurements in percent SL: head length 14.8–16.9; head width 8.6–9.5; pectoral fin length 9.2–10.5; predorsal length 17.6–19.7; preanal length 41.3–44.2; body height 9.6–11.8; gill slit length 5.8–6.7; caudal fin length 3.4–5.0. Following measurements in percent HL: head width 52.7–64.5; upper jaw length 35.5–45.6; pectoral fin length 54.6–66.0; snout length 19.1–23.2; eye diameter 15.2–20.2; gill slit length 34.9–41.8; interorbital width 6.9–10.3; interpupillary width 21.1–25.3; pelvic fin length 12.2–18.0. Pectoral base/length ratio 38.9–50.9.

DIAGNOSIS.—Pelvic fins present; dorsal gill rakers on first arch bi- or tricuspid at tips (adults and subadults); scales absent on nape and abdomen; postorbital pores four; vertebrae 26–28 + 75–79 = 101–107; origin of mediolateral lateral line near dorsal margin of pectoral base; occipital pores present or absent.

DESCRIPTION.—Head ovoid, snout not bluntly rounded (as some species), but steep anteriorly. Scales extending anteriorly on body in wedge-shaped pattern to vertical from half pectoral fin

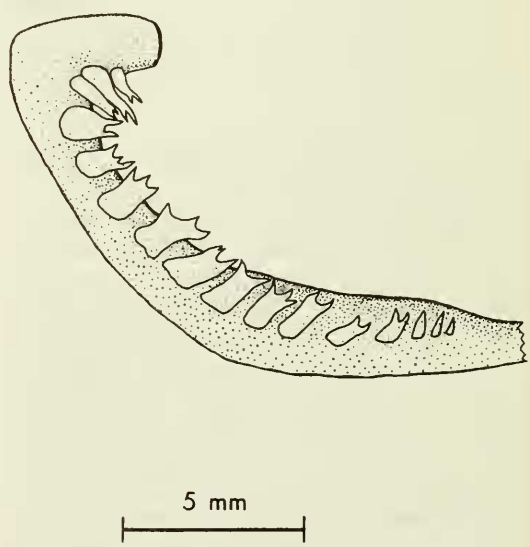

FIGURE 8. Outer surface of right first gill arch of holotype of *Pachycara crossacanthum* n. sp., showing furcated gill rakers; gill lamellae not shown.

FIGURE 9. *Pachycara sulaki* n. sp., USNM 292811, holotype, 189 mm SL, from off Puerto Rico.

length posterior to pectoral margin (usually in smallest specimens) to vertical through middle of pectoral; scales absent on abdomen, nape, pectoral axil and base. Eye ovoid, entering dorsal profile of head. Gill slit short, not reaching ventral margin of pectoral base. Lobe at dorsal margin of gill slit rounded and weakly developed in three specimens (including holotype), squared-off and well defined in others. Pectoral fin origin well below body midline, insertion on abdomen; posterior margin of fin evenly rounded, middle rays longest; ventralmost four or five rays thickened, tips slightly exserted.

Mouth subterminal, oblique, upper jaw extending posteriorly to middle of eye, or slightly in advance. No epidermal prickles evident on snout or lips. Oral valve weak, not reaching anterior edge of vomer, and not coalesced with lateral margin of palate opposite vomer. Jaw teeth in large specimens long, sharp, retrorse anteriorly; dentary with 4–5 irregular rows anteriorly, blending into single posterior row; premaxilla with two (males) or three (females) anterior rows, blending into single posterior row. Vomerine teeth in irregular patch; palatine teeth not retrorse, in double row in large females, in single row in all others.

Cephalic lateralis system with four postorbital pores arising from frontal (pore one), pterotic (pore two), between pterotic and lateral extrascapular (pore three) and just posterior to lateral extrascapular (pore four). Two pairs of anterior supraorbital (nasal) pores, one set mesial to nasal tube, the other posteriorly. Seven suborbital pores, six arising from ventral ramus of bone chain and one from ascending ramus behind eye just ventral to first postorbital pore. Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular and three from preopercle. Interorbital and occipital pores absent, except in CAS 62408 which has three minute occipital pores and MNHN 1988-1170, 227 mm SL, which has a single, right lateral occipital pore. Body lateral line with mediolateral branch originating in pectoral axil near dorsal margin of pectoral base; ventral branch originating just posterior to fourth postorbital pore; both branches complete to tail tip.

Dorsal fin origin associated with vertebra four. Anal fin origin associated with ultimate precaudal vertebra (numbers 26–28), with three anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra, last anal ray associated with second preural vertebra. Caudal fin with 1–2 epural, 4–5 upper and 4-6 lower hypural rays.

Gill rakers on upper limb (epibranchial) of first arch long, sharply pointed in young, bi- or trifurcate in large specimens; rakers on lower limb (ceratobranchial) tubular, those of large specimens with bi-or tricuspid tips (Fig. 8); lowermost 1–4 rakers of some specimens simple, pointed. Branchiostegal rays six. Pseudobranch filaments 4–5, tips furcate in large specimens.

Color uniformly dark brown, margins of dorsal, anal and pectoral fins black; eye and abdomen bluish. Peritoneum and inner palate black. Lips and lining of lateral sides of palate white.

DISTRIBUTION.—Known off western tropical Africa from Senegal to Gabon on the upper continental slope at depths of 900–1,050 m (Fig. 5).

ETYMOLOGY.—From the Greek *κρόσσος* (fringe) and *ἄκανθα* (thorn) in reference to the species' furcate gill rakers.

Pachycara sulaki n. sp.

(Figs. 5, 9)

Zoarcid fish. Paull et al., 1984:965, 966.
Pachycara sp. Anderson et al., 1986:800.

HOLOTYPE.—USNM 292811 (male, 189 mm); Mona Passage off Puerto Rico (18°28.7′N, 67°20.6′W); PEZMAR, Deep Trapping Project, sta. 36; medium fish trap, 2,000 m; D. A. Hensley, 12–13 Feb. 1986.

PARATYPES.—USNM 233627 (female, 161 mm); Venezuela Basin, Caribbean Sea (13°31.3–25.7′N, 64°45.1–40.4′W); USNS BARTLETT sta. E092; trawl, 3,510–3,469 m; M. D. Richardson and party, 28 Nov. 1981. SIO 87-33 (female, 133 mm);

Florida Escarpment, Gulf of Mexico (26°05′N, 84°54′W); DSV ALVIN dive 1771; Floc Sucker, 3,303 m; C. Paull and party, 7 Nov. 1986.

Counts and Measurements.—Vertebrae 27–30 + 80–85 = 107–113; D 99–107; A 81–89; C 9–11; P_1 16–17; P_2 0 or 3; vomerine teeth 4–8; palatine teeth 4–7; gill rakers 2–3 + 9–13 = 11–16; branchiostegal rays six; pseudobranch filaments 3–4. Following measurements in percent SL: head length 14.8–17.7; head width 7.3–9.0; pectoral fin length 9.8–10.6; predorsal length 20.8–23.5; preanal length 39.0–41.7; body height 8.3–9.5; gill slit length 4.8–6.5; caudal fin length 2.1–3.8. Following measurements in percent HL: head width 47.8–56.1; upper jaw length 36.4–50.0; pectoral fin length 55.5–68.8; snout length 16.4–20.1; eye diameter 17.8–23.9; gill slit length 28.0–42.1; interorbital width 6.4–10.5; interpupillary width 23.8–32.8; pelvic fin length 5.7–13.9 (in two). Pectoral base/length ratio 38.9–40.0.

Diagnosis.—Pelvic fins present or absent; origin of mediolateral lateral line just posterior to last (fourth) postorbital pore; origin of ventral lateral line on or behind vertical through posterior third of pectoral fin; suborbital pores 5–6; dorsal fin origin associated with vertebrae 6–7; vertebrae 27–30 + 80–85 = 107–111; predorsal length 20.8–23.5% SL.

Description.—Head ovoid, long, dorsal profile evenly tapering; snout bluntly rounded. Scales extending anteriorly on body in wedge-shaped pattern to vertical through middle of pectoral fin (all three specimens juveniles; adults probably more densely scaled); scales absent in these juveniles on dorsal fin anteriorly (present on posterior third), abdomen, head, nape, pectoral base and axil. Eye circular, entering dorsal profile of head. Gill slit reaching ventral margin of pectoral base or just above it. Lobe at dorsal margin of gill slit weak, rounded. Pectoral fin origin just below body midline, insertion on abdomen; posterior margin of fin evenly rounded, middle rays longest; ventralmost five rays thickened, tips slightly exserted. Pelvic fins present except in SIO 87-33; of three soft rays each in other two specimens.

Mouth subterminal, oblique, upper jaw extending posteriorly to middle of eye in females (paratypes), or its rear margin in male holotype. No epidermal prickles evident on snout or lips. Oral valve well developed in these small specimens, overlapping anterior edge of vomer and not coalesced with lateral margins of plate opposite vomer. Jaw teeth relatively long and sharp in male, smaller and conical in females; outer jaw teeth retrorse; both jaws (all specimens) with two irregular rows of teeth blending into single, posterior row. Vomerine teeth in irregular patch, enlarged in male; palatine teeth not retrorse, in single row.

Cephalic lateralis system with two postorbital pores arising from frontal (pore one) and lateral extrascapulars (pore four). Two pairs of anterior supraorbital (nasal) pores, one set mesial to nasal tube, the other posteriorly. Five (USNM 233627) or six suborbital pores, all arising from ventral ramus of bone chain. Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular and three from preopercle. Interorbital and occipital pores absent. Superficial neuromasts prominent on head an anterior portion of body, with series on preopercle, behind eye running along occiput in converging row, around rictus of mouth, and snout between nostrils. Body lateral line with mediolateral branch originating just behind posteriormost (number four) postorbital pore; this branch undulating across body somewhat, then straightening above anus; ventral branch originating on or slightly behind (holotype) posterior third of pectoral fin; both branches complete to tail tip.

Dorsal fin origin associated with vertebrae 6–7. Anal fin origin associated with penultimate or ultimate precaudal vertebrae (numbers 26–30), with 3–5 anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra, last anal ray associated with second preural vertebra. Caudal fin with two epural, 3–5 upper hypural and four lower hypural rays.

Gill rakers on upper limb (epibranchial) and dorsalmost rakers on lower limb (ceratobranchial) narrow and sharply pointed; ventralmost ceratobranchial rakers blunt, triangular. Branchiostegal rays six. Pseudobranch filaments long, numbering 3–4.

Live color notes or photographs of all three specimens available, each one quite different. Holotype uniformly dark chocolate brown, as most other congeners, unpaired fins black, eye blue. Paratype USNM 233627 from the Caribbean Sea with lustrous dark blue body, typical of many deep-sea fishes such as halosaurs and

alepocephalids (Markle 1980, fig. 1), head and pectoral fins black. Paratype SIO 87-33 relatively blanched, body uniformly sandy gray, occiput, nape and pectoral axil occupied by a wide, white band, eye and abdomen blue, unpaired fins translucent.

DISTRIBUTION.—Known only from three specimens taken in abyssal waters of the tropical northwestern Atlantic at depths of 2,000–3,510 m (Fig. 5).

ETYMOLOGY.—Named after Kenneth J. Sulak, intrepid explorer of the great murky depths of the Atlantic Ocean, to honor his many contributions to knowledge of the deep-sea fishes of this and adjacent regions.

Pachycara shcherbachevi n. sp.

(Figs. 5, 10)

HOLOTYPE.—ZMUC P-761147 (female, 236 mm SL); Bay of Bengal (15°54.0′N, 90°17.0′E); GALATHEA sta. 314; trawl (HOT/4800), 2,600 m; 1930 hr; 3 May 1951.

COUNTS AND MEASUREMENTS.—Vertebrae 32 + 90 = 122; D 112; A 94; C 12; P_1 17; P_2 3; vomerine teeth two; palatine teeth 4/4; gill rakers 2 + 14; branchiostegal rays six; pseudobranch filaments three. Following measurements in percent SL: head length 11.4; head width 7.7; pectoral fin length 10.0; predorsal length 16.6; preanal length not measurable; body height 7.7; caudal fin length 3.0. Following measurements in percent HL: head width 67.7; upper jaw length 39.0; pectoral fin length 87.7; snout length 16.0; eye diameter 23.8; interorbital width 13.8; interpupillary width 28.6; pelvic fin length 8.9. Pectoral base/length ratio 36.0.

DIAGNOSIS.—Pelvic fins present; vertebrae 32 + 90 = 122; dorsal fin origin associated with vertebra eight; head length 11.4% SL.

DESCRIPTION.—Specimen trawl damaged—completely skinned, body torn before anus; scales, lateral line, and most head pores not evident. Head ovoid, small; its length shorter in relation to SL than any *Pachycara* specimen, irregardless of size. Eye large, ovoid, entering dorsal profile of head when viewed laterally. Gill opening damaged, tissue covering branchiostegal membranes torn, but adhering on left side in places, and, with skin along pectoral base, gill opening appearing to extend ventrally to just above lower pectoral base. Dorsal margin of gill slit with short, anteriorly directed emargination. Pectoral fin origin well below body midline, insertion on abdomen; posterior margin of fin (from reconstruction utilizing both fins) evenly rounded, middle rays longest; ventralmost four rays thickened.

Mouth subterminal, upper jaw (premaxilla and maxilla with some flesh) posteriorly relatively high, somewhat rectangular. Oral valve reaching anterior edge of vomer and coalesced with lateral margin (left) of palate opposite vomer. Jaw teeth small, conical, retrorse anteriorly; dentary with 14 teeth in two irregular rows anteriorly, blending into single, posterior row; premaxillae with 13 (right) or 11 (left) teeth, also in two irregular rows anteriorly, blending into single, posterior row. Two small vomerine teeth. Four palatine teeth on both bones, in short row.

Cephalic lateralis pores evident from connective tissue tubules and impressions in exposed subdermal lipid layer, not all pores remaining. Presumably two pairs of anterior supraorbital pores mesial to nasal tube. Six suborbital pores, all arising from ventral ramus of bone chain under eye. Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular, and three from preopercle. Interorbital and occipital pores presumably absent. Postorbital pores one (behind eye) and four (anterodorsal upper end of gill slit) observed, others (pore two and three) may or may not be present in the species.

Dorsal fin origin associated with vertebra eight; posteriormost origin in genus, except for *P. rimae,* n. sp., which also has dorsal origin with eighth vertebra. Anal fin origin associated with penultimate precaudal vertebra (number 31), with four anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra; last anal ray associated with second preural vertebra. Caudal fin with two epural, five upper hypural, and five lower hypural rays.

Gill rakers small, sharply pointed and pyramidal dorsally; ventralmost five much smaller than dorsalmost, but distinct. Branchiostegal rays six. Pseudobranch filaments three, very small.

Color unknown, but bits of black skin adhere to head, body, and fins. Perhaps all black in life. Peritoneum black. Lining of orobranchial chamber dark brown in alcohol, probably black in life also.

DISTRIBUTION.—Known from a single specimen from the abyssal Bay of Bengal, northwest of the Andaman Islands, in 2,600 m (Fig. 5).

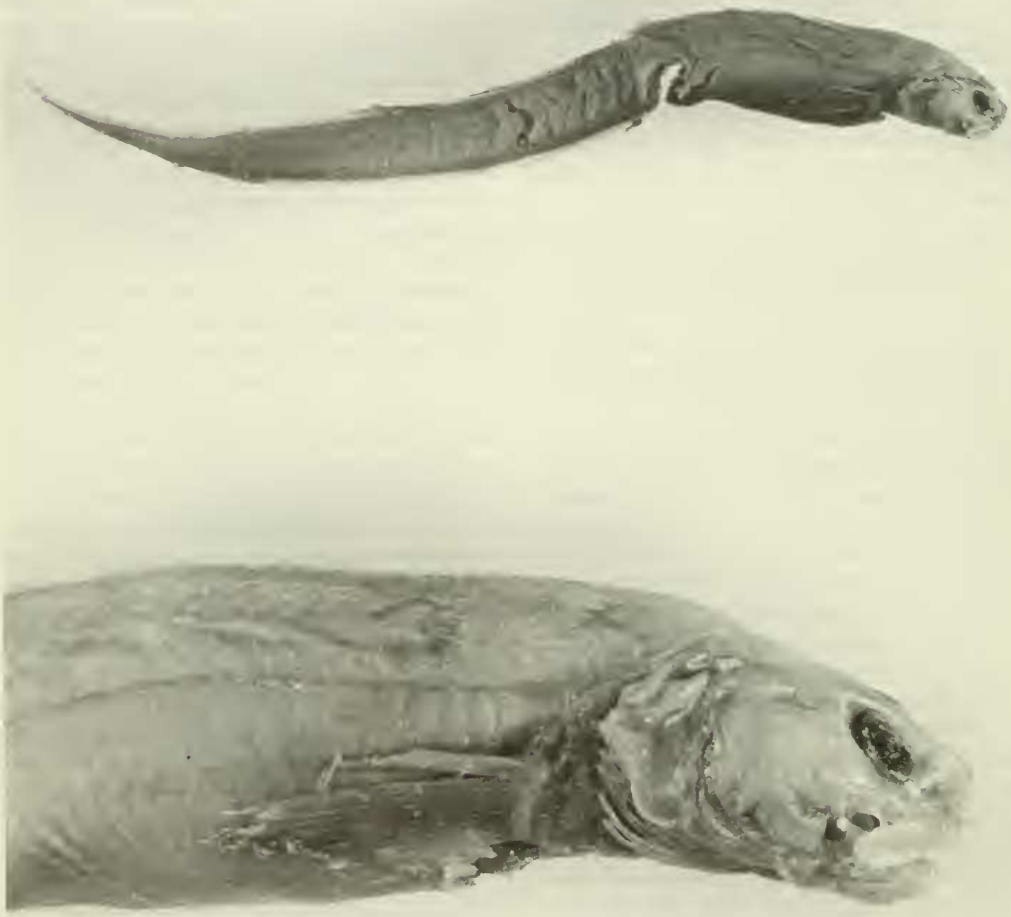

FIGURE 10. *Pachycara shcherbachevi* n. sp., ZMUC P-761147, holotype, 236 mm SL, Bay of Bengal (specimen damaged by trawl).

ETYMOLOGY.—Named after Yuri Nikolaevich Shcherbachev, P. P. Shirshov Institute of Oceanology, Academy of Sciences, USSR, friend and colleague, in honor of his pioneering contributions to knowledge of the deep-sea fishes of the Indian Ocean.

Pachycara gymninium Anderson and Peden, 1988

(Fig. 11)

Lycodes sp. Hubbs et al., 1979:14.
Lycenchelys "E." Pearcy et al., 1982:387.
Pachycara gymninium Anderson and Peden, 1988:88–91, fig. 5.

MATERIAL EXAMINED.—See Anderson and Peden (1988:88–89).

DIAGNOSIS.—Pelvic fins present, their length 4.8–11.3% HL; mediolateral lateral line originating in pectoral axil just posterior to vertical through pectoral base; scales absent on nape, or, if present, not extending anterior to line connecting anterodorsal edges of gill slits; vertebrae 28–31 + 73–80 = 102–109; D 96–103; A 77–84; P_1 14–18; dorsal fin origin associated with vertebrae 3–5; anal fin origin associated with vertebrae 27–31; gill rakers 3–5 + 10–14 = 13–19; branchiostegal rays six; suborbital pores 6–7; postorbital pores 2–3; head length 12.0–15.6% SL; pectoral fin length 63.0–70.8% HL.

DISTRIBUTION.—Eastern North Pacific off the Queen Charlotte Islands, Canada, south to the Gulf of California at depths of 1,829–3,225 m (Fig. 11).

Pachycara lepinium Anderson and Peden, 1988

(Fig 11)

Lycodes sp. Hubbs et al., 1979:14.
Lycenchelys "D." Pearcy et al., 1982:387.
Pachycara lepinium Anderson and Peden, 1988:91–92, fig. 6.

MATERIAL EXAMINED.—See Anderson and Peden (1988:91).

DIAGNOSIS.—Pelvic fins present, their length 11.5–17.3% HL; mediolateral lateral line originating posterior to pectoral fin margin; scales present on nape; vertebrae 23–26 + 80–94 = 105–120; D 99–113; A 85–98; P_1 15–18; dorsal fin origin associated with vertebrae 4–5; anal fin origin associated with vertebrae 23–26; gill rakers 2–5 + 11–15 = 12–19; branchiostegal rays six; suborbital pores six; postorbital pores 2–3; head length 13.8–15.9% SL; pectoral fin length 72.5–89.9% HL.

DISTRIBUTION.—Eastern North Pacific off the Queen Charlotte Islands, Canada, south to off Cabo Colnett, Baja California Norte, Mexico, at depths of 1,728–2,907 m (Fig. 11).

Pachycara suspectum (Garman, 1899)

(Fig. 11)

Phucocoetes suspectus Garman, 1899:137, pl. XXX, figs. 3, 3a.
Pachycara suspectum (Garman). Anderson and Peden, 1988: 88, fig. 4.

MATERIAL EXAMINED.—See Anderson and Peden (1988:88).

DIAGNOSIS.—Pelvic fins present; lateral line of ventral branch only; scales absent on nape; vertebrae 21–23 + 84–87 = 105–110; D 100–106; A 85–89; P_1 16; dorsal fin origin associated with vertebrae 2–3; anal fin origin associated with vertebrae 20–22; gill rakers 1–2 + 14–15 = 16; branchiostegal rays six; suborbital pores seven; postorbital pores three; head length 15.6–17.7% SL; pectoral fin length 57.4–58.6% HL.

DISTRIBUTION.—Eastern North Pacific in the Gulf of California south to the Gulf of Panama at depths of 915–1,280 m (Fig. 11).

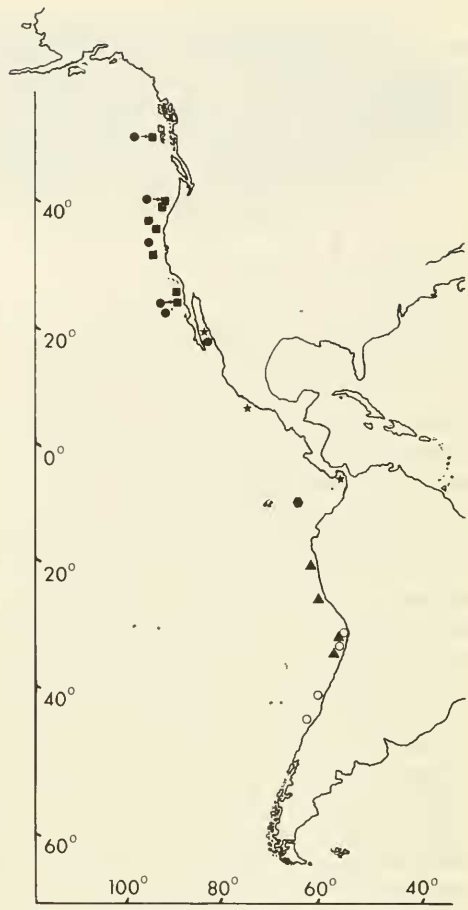

FIGURE 11. Distribution of eastern Pacific species of *Pachycara*. Closed circles: *P. gymninium*; squares: *P. lepinium*; hexagon: *P. rimae*; triangles: *P. mesoporum*; stars: *P. suspectum*; open circles: *P. pammelas*.

Pachycara rimae n. sp.

(Figs. 11, 12)

Zoarcidae (partim). Cohen and Haedrich, 1983:376.
Pachycara (?). Cohen et al., 1985:229.

HOLOTYPE.—LACM 44699-1 (male, 403 mm SL); vic. Galapagos Rift hydrothermal vents (00°47.8′N, 86°09.9′W); DSV ALVIN; baited trap, 2,500 m; J. Corliss, 16 Mar. 1977.

FIGURE 12. *Pachycara rimae* n. sp., LACM 44699-1, holotype, 403 mm SL, Galapagos Rift Zone. Illustration of right side shown in left lateral view (left side damaged).

COUNTS AND MEASUREMENTS.—Vertebrae 26 + 67 = 93; D 86; A 70; C 9; P_1 15; P_2 2; vomerine teeth three; palatine teeth 8–9; gill rakers 3 + 7; branchiostegal rays four or five; pseudobranch filaments absent. Following measurements in percent SL: head length 13.7; head width 10.1; pectoral fin length 9.3; predorsal length 21.6; preanal length 44.2; body height 14.1; gill slit length 6.0; caudal fin length 1.7. Following measurements in percent HL: head width 74.2; upper jaw length 54.3; pectoral fin length 68.1; snout length 18.9; eye diameter 13.0; gill slit length 43.7; interorbital width 12.7; interpupillary width 42.1; pelvic fin length 4.2. Pectoral base/length ratio 42.7.

DIAGNOSIS.—Pelvic fins nublike, of two soft rays; vertebrae 26 + 67 = 93; D 86; A 70; lateral line of mediolateral branch only; dorsal fin origin associated with vertebra eight; pseudobranch absent; branchiostegal rays four or five; suborbital pores five; gill rakers 10.

DESCRIPTION.—Head deep, rounded, somewhat shorter than similarly sized congeners. Snout steeply sloping anteriorly. Left side of body and tail damaged, but skin pliable around head and dorsum owing to subdermal lipid layer. Scales extending anteriorly on body in wedge-shape pattern to vertical just anterior to posterior margin of pectoral fin; scales absent on head, nape, dorsum, pectoral base, abdomen, and unpaired fins. Eye small, circular, entering dorsal profile of head when viewed laterally. Gill slit short, extending ventrally to opposite pectoral ray 12. Lobe at dorsal margin of gill slit weakly developed, gill slit not continued anteriorly. Pectoral fin origin well below body midline; left pectoral fin badly damaged in capture, right fin deformed, apparently injured in life, with tips of dorsalmost four rays missing (Fig. 12); six ventralmost pectoral rays thickened, slightly exserted at tips.

Mouth terminal, oblique, upper jaw extending posteriorly to middle of eye or beyond (snout region twisted to one side). No epidermal prickles evident on snout or lips. Oral valve just reaching anterior margin of vomer and coalesced with lateral margins of palate opposite vomer. Teeth small, conical, sharp. Jaw teeth in double row anteriorly, blending into single, posterior row. Vomerine teeth three, in an arc; palatine teeth in single row.

Cephalic lateralis system with two postorbital pores arising from frontal (pore one) and lateral extrascapular (pore four). Two pairs of anterior supraorbital (nasal) pores, one set anteromesial to nasal tube, the other posteromesially. Five suborbital pores, all arising from ventral ramus of suborbital bone chain. Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular, and three from preopercle. Interorbital and occipital (supratemporal) pores absent. Body lateral line mediolateral, originating posterior to rear margin of pectoral fin, complete to tail tip; no ventral branch.

Dorsal fin origin associated with vertebra eight. Anal fin origin associated with ultimate precaudal vertebra (number 26), with two anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra, last anal ray associated with second preural vertebra. Caudal fin with two epural, four upper hypural, and four lower hypural rays.

Gill rakers very short, triangular, lowermost rakers on first arch mere nubs; raker denticles absent. Branchiostegal rays four on right side (two articulating with ceratohyal, two with epihyal) and five on left side (three articulating with ceratohyal, two with epihyal). Pseudobranch absent.

Color uniformly light brown (Cohen et al. 1985: 229); eye and abdomen bluish. Peritoneum and lining of orobranchial chamber dark brown in alcohol, probably black in life. Head and right

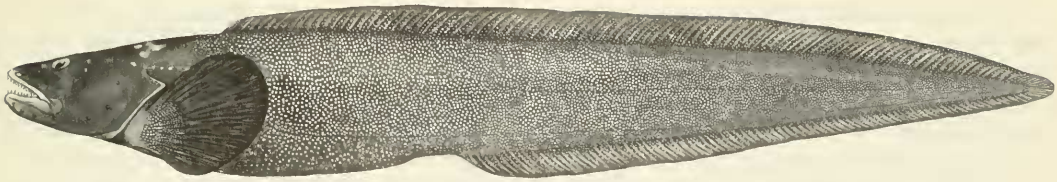

FIGURE 13. *Pachycara mesoporum* n. sp., CAS 62406, holotype, 485 mm SL, from off Antofagasta, Chile.

pectoral fin with scattered whitish blotches and streaks.

DISTRIBUTION.—Known only from the holotype taken in the abyssal southeastern Pacific in 2,500 m.

ETYMOLOGY.—From the Latin "rima" (fissure). A genitive noun in apposition, alluding to the species' capture at the Galapagos Rift Zone (Cohen and Haedrich 1983; Cohen et al. 1985).

Pachycara mesoporum n. sp.

(Figs. 11, 13)

HOLOTYPE.—CAS 62406 (male, 485 mm); off Antofagasta, Chile; Chilean fisheries vessel; trawl, depth uncertain (ca. 300 ? m); I. Kong Urbina, 18 Apr. 1986.

PARATYPES.—LACM 43717-1 (5; 170–217 mm); off Trujillo, Peru (08°26′S, 80°36.5′W); ANTON BRUUN sta. 650E; free vehicle set line trap, 1,830 m; L. Knapp and party, 8–9 June 1966. ZIN 48394 (male, 189 mm); off Laguna Grande, Peru (14°44′S, 76°12′W); DMITRY MENDELEEV cr. 20, sta. 1654; Galathea trawl, 1,495–1,430 m; N. V. Parin, 2335–0120 hr, 19–20 Mar. 1978. MNHNC 6653 (female, 318 mm); off Arica, Chile (18°26′S, 70°37′W); TIBERIADES; trawl, 760 m; I. Kong Urbina, 17 Feb. 1981.

COUNTS AND MEASUREMENTS.—Vertebrae 24–26 + 78–87 = 103–113; D 96–108; A 80–90; C 9–10; P_1 15–18; P_2 absent or three; vomerine teeth 3–12; palatine teeth 2–11; gill rakers 2–3 + 11–16 = 13–18; branchiostegal rays six; pseudobranch filaments 3–4. Following measurements in percent SL: head length 12.6–15.9; head width 6.1–8.2; pectoral fin length 8.8–12.1; predorsal length 15.1–18.1; preanal length 33.6–38.1; body height 7.8–9.5; gill slit length 4.1–6.9; caudal fin length 2.1–3.2. Following measurements in percent HL: head width 44.6–52.5; upper jaw length 34.7–51.7; pectoral fin length 57.1–81.1; snout length 16.0–21.2; eye diameter 17.2–22.9; gill slit length 28.1–44.3; interorbital width 5.9–9.0; interpupillary width 24.0–29.6; pelvic fin length 8.0–8.8 (in two of eight). Pectoral base/length ratio 32.8–46.3.

DIAGNOSIS.—Pelvic fins present or absent; single, mesial occipital pore present; postorbital pores 3–4; mediolateral lateral line originating slightly anterior to vertical through posterior margin of pectoral fin; ventral lateral line originating just posterior to last postorbital pore; vertebrae 24–26 + 78–87 = 103–113.

DESCRIPTION.—Following description based on one adult male (holotype), one adult female (MNHNC 6653), three juvenile males, and three juvenile females. Head ovoid in juveniles and adult female, more triangular in adult male. Male with dorsoventrally depressed head and straighter snout than others; adult female and juveniles with bluntly rounded snouts. Scales extending anteriorly to vertical through dorsal fin origin, or slightly anterior to it; scales absent on nape (rare or absent anterior to line connecting upper edge of gill slit and dorsal fin origin). Scales present on unpaired fins (almost to their margin posteriorly), abdomen to isthmus, in pectoral axil and on pectoral base except adult female and one juvenile male. Eye ovoid, more rounded in adult male, entering dorsal profile of head except in adult female; eye diameter 17.2% HL in adult male, 20.2–22.9% HL in others. Gill slit short, not reaching ventral margin of pectoral base except in adult male, in which it reaches slightly beyond lowest pectoral ray; gill slit length 42.2% HL in male, 28.1–34.0% HL in juveniles, and 44.3% HL in adult female owing to its anterior extension (below). Lobe at dorsal margin of gill slit small, squared-off in holotype and some juveniles; dorsal margin not extending anteriorly in some juveniles; operculum broadly rounded and extending anteriorly almost one eye diameter in adult female. Pectoral fin origin on body midline in smallest juveniles, well below midline in adults, insertion on abdomen; posterior margin of fin usually evenly rounded, middle rays longest, however, female with left fin distinctly wedge-shaped and right fin injured, with tips of upper and middle rays missing (fin deeply notched). Ventralmost four or five pectoral rays thickened, tips slightly exserted.

Mouth subterminal, oblique, snout and upper jaw more produced in adult male than others; upper jaw extending posteriorly to rear margin of eye in adult male (upper jaw length 51.7% HL), or to middle of eye in others (37.1–42.1% HL in adult female and juveniles). No epidermal prickles evident on snout or lips. Oral valve weak, not reaching anterior edge of vomer in adults, but not coalesced with lateral margin of palate opposite vomer in any specimen. Jaw teeth in adult male long, caniniform, slightly retrorse (Fig. 13); dentary with three irregular rows anteriorly, blending into single, posterior row; premaxilla with two irregular anterior rows, blending into single, posterior row; outer row on premaxilla about five times as large as inner row. Jaw teeth in adult female and juveniles small, blunt, conical; dentary with four irregular rows anteriorly (juveniles with 2–3 rows), blending into single, posterior row; premaxilla with three irregular anterior rows (juveniles with two), blending into single, posterior row. Vomerine teeth in irregular patch or gradual arc (holotype). Vomerine and palatine teeth retrorse and caniniform in adult male, small, blunt and conical in others; palatine teeth in irregular, double row in adult female, in single row in others.

Cephalic lateralis system with three postorbital pores arising from frontal (pore one), between pterotic and lateral extrascapular (pore three), and just posterior to lateral extrascapular (pore four) except in adult female in which pore two is present on both sides, arising from pterotic. Two pairs of anterior supraorbital (nasal) pores, one set mesial to nasal tube, the other posteriorly (posteromesially in adult male). Usually seven suborbital pores, with six arising from ventral ramus of bone chain and one from ascending ramus behind eye. Exceptions to this are: (1) LACM 43717-1, 192 mm, which has five pores arising from ventral ramus and one from ascending ramus on right side, and five from ventral ramus and two from ascending ramus on left side; and (2) LACM 43717-1, 172 mm, which has suborbital pores two and four oddly doubled (pore at these positions are situated one atop the other) and no third pore, giving seven pores arising from ventral ramus and one from ascending ramus. Eight preoperculomanibular pores, four arising from dentary, one from anguloarticular and three from preopercle. Interorbital pores absent. Occipital (supratemporal) canal with single, mesial pore in all. Body lateral line with mediolateral branch originating on vertical about one eye diameter anterior to posterior margin of pectoral fin; mediolateral branch not visible in greatly faded juveniles in LACM 43717-1; ventral branch originating just posterior to fourth postorbital pore, gradually descending across abdomen to above anal fin base; both branches complete to tail tip.

Dorsal fin origin associated with vertebrae 4–5. Anal fin origin associated with ultimate precaudal vertebra (numbers 24–26), with 3–4 anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with second, fourth, or fifth preural vertebrae, last anal ray associated with second preural vertebra. Caudal fin with 1–2 epural, four upper hypural, and 4–5 lower hypural rays. Pelvic fins absent except in MNHNC 6653 and ZIN 48394 which have small, fleshy fins of three rays each.

Gill rakers on upper limb (epibranchial) of first arch moderately long, sharply pointed; ventralmost rakers on lower limb (ceratobranchial) of adult female and juveniles small, but sharply pointed, those of adult male blunt, with squared-off tips. Branchiostegal rays six. Pseudobranch filaments long, numbering 3–4.

Recently preserved specimens (collected 1978–1986) uniformly dark brown in alcohol, probably black in life. Eye blue. Peritoneum, lining of gill cavity and inner palate black. Outer palate and lips pale.

Distribution.—Known from eight specimens taken off western South America from the upper slope to the edge of the Peru-Chile Trench, reliably known from depths of 760–1,830 m (Fig. 11). Capture depth of holotype unknown; from fisheries vessel.

Etymology.—From the Greek *μέσος* (middle) and *πόρος* (hole, pore) in reference to the unique condition of the species' occipital canal with its single, mesial pore.

Remarks.—This is the second species of *Pachycara* known in which pelvic fins are present or absent (the other is *P. sulaki*) and the fourth zoarcid reported with this condition (others are *Crossostomus chilensis* [see Gosztonyi 1977] and *Lycenchelys monstrosa* [see Anderson 1982b]). The two specimens with pelvic fins (ZIN 48394 and MNHNC 6653) also exhibit slightly elevated vertebral counts (111 and 113 vs. 103–106 for others), higher gill raker counts (16 and 18 vs.

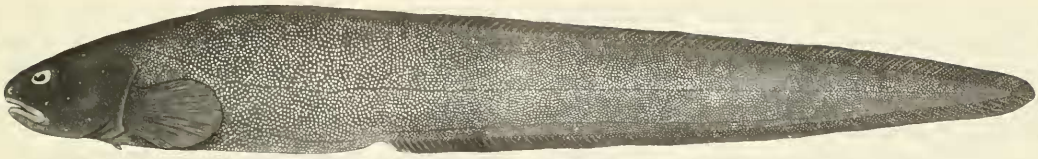

FIGURE 14. *Pachycara pammelas* n. sp., CAS 62407, holotype, 336 mm SL, from off Punta Lobos, Chile.

13–15 for others), and higher pectoral ray counts (16 and 18 vs. 15–16 for others). It was tempting to consider the presence of two closely related species with mesial occipital pores in the sample of eight specimens. However, this unique condition, plus the identical lateral lines, squamation, and state of dentition, makes it apparent that the noted anatomical differences cannot be considered above the range of individual variation found in either other *Pachycara* species represented by larger sample sizes, or other zoarcids.

Pachycara pammelas n. sp.

(Figs. 11, 14)

HOLOTYPE.—CAS 62407 (female, 336 mm); off Punta Lobos, Chile (20°50′S, 70°27′W); Chilean fisheries vessel; trawl, 610 m; I. Kong Urbina, 21 Feb. 1981.

PARATYPES.—SIO 72-183 (2; 96–192 mm); off Arica, Chile (18°44.7–40.2′S, 70°40.7–35.1′W); South Tow Exped., 1,097–1.152 m; R. L. Wisner and party, 1152–1330 hr, 7 May 1972. LACM 43732-1 (2; 152–217 mm); off Coquimbo, Chile (30°06.0′S, 71°42.6′W); ANTON BRUUN sta. 708; free vehicle set line trap, 1,000 m; L. W. Knapp and party, 14 Aug. 1966. LACM 43726-1 (2; 226–231 mm); off Valpariso, Chile (33°39.0′S, 72°09.5′W); ANTON BRUUN sta. LWK 66-41; trawl, 1,170–1,480 m; L. W. Knapp and party, 10 Aug. 1966.

COUNTS AND MEASUREMENTS.—Vertebrae 23–26 + 81–88 = 105–114; D 99–109; A 83–92; C 10–11; P_1 15–18; P_2 3; vomerine teeth 3–9; palatine teeth 2–14; gill rakers 1–3 + 12–17 = 14–20; branchiostegal rays six; pseudobranch filaments 2–5. Following measurements in percent SL: head length 12.8–15.6; head width 5.7–9.0; pectoral fin length 7.1–9.2 predorsal length 15.0–18.4; preanal length 34.0–37.0; body height 6.3–10.5; gill slit length 4.0–6.4; caudal fin length 1.6–2.7. Following measurements in percent HL: head width 39.9–67.4; upper jaw length 34.1–52.7; pectoral fin length 50.8–64.2; snout length 15.6–22.2; eye diameter 19.5–30.4; gill slit length 25.7–50.2; interorbital width 6.7–8.9; interpupillary width 23.7–33.2; pelvic fin length 7.4–13.3. Pectoral base/length ratio 33.0–51.4.

DIAGNOSIS.—Pelvic fins present; origin of mediolateral lateral line immediately posterodorsal last postorbital pore; origin of ventral lateral line immediately posterior to last postorbital pore; vertebrae 23–26 + 81–88 = 105–114; no scales on nape.

DESCRIPTION.—Following description based on one adult female (holotype), two juvenile males, and four juvenile females. Head ovoid, snout bluntly rounded in females giving head more rounded appearance than males. Males (152 and 192 mm) with head elongate, dorsoventrally depressed, snout long, gently tapering. Scales extending anteriorly on body to nape where present in patch extending in front of dorsal fin origin in holotype (absent there in smaller paratypes); scales present on unpaired fins (except 96 mm juvenile), abdomen, pectoral axil and base (latter in holotype only). Eye ovoid, entering dorsal profile of head. Gill slit short, extending just to lower margin of pectoral base or slightly above. Lobe at dorsal margin of gill slit weak, gill slit not extending anteriorly in largest male; lobe rounded or squared-off. Pectoral fin origin well below body midline in larger specimens (closer to midline in smallest two), insertion on abdomen; posterior margin of fin evenly rounded, middle rays longest; ventralmost four or five rays thickened, tips very slightly exserted.

Mouth subterminal, oblique, snout more produced in males than females; upper jaw extending posteriorly to middle of eye in females, to just beyond its posterior margin in largest male. No epidermal prickles evident on snout or lips. Oral valve well developed, overhanging anterior margin of vomer in holotype, coalesced with sides of palate posterior to vomer in all. Jaw teeth small, blunt, conical; dentary with four irregular rows anteriorly in holotype, blending into single, posterior row consisting of 2–4 teeth; dentary teeth in two to four (largest two paratypes, LACM 43726-1) irregular anterior rows in others, blending into single, posterior row. Premaxilla with two anterior rows of teeth, blending into single,

posterior row except in smallest specimen (SIO 72-183, 96 mm) which has single row of nine teeth. Vomerine teeth in patch or arc (small specimens); palatine teeth blunt, not retrorse, in double row in holotype, single row in others.

Cephalic lateralis system with three postorbital pores arising from frontal (pore one), between pterotic and lateral extrascapular (pore three), and posterior to lateral extrascapular (pore four). Largest male (SIO 72-183, 192 mm) with pores one and four only. Two pairs of anterior supraorbital (nasal) pores, one set mesial to nasal tube, the other posteriorly. Seven suborbital pores, six arising from ventral ramus of bone chain and one from ascending ramus behind eye just ventral to first postorbital pore; eight suborbital pores on right side only in LACM 43732-1, 152 mm). Eight preoperculomandibular pores, four arising from dentary, one from anguloarticular, and three from preopercle. Interorbital and occipital pores absent. Body lateral line difficult to detect in faded paratypes, clear in holotype; mediolateral branch originating about half an eye diameter or less posterodorsal to last (number four) postorbital pore; ventral branch originating immediately posterior to postorbital pore four; both branches complete to tail tip.

Dorsal fin origin associated with vertebra 4–5. Anal fin origin associated with ultimate or penultimate precaudal vertebrae (numbers 23–26), with 2–4 anal pterygiophores inserted anterior to haemal spine of first caudal vertebra. Last dorsal ray associated with fourth preural vertebra, last anal ray associated with second preural vertebra. Caudal fin with two epural, 4–5 upper hypural and four lower hypural rays.

Gill rakers on upper limb (epibranchial) of first arch simple, sharply pointed; rakers on lower limb (ceratobranchial) laterally compressed, with squared-off tips; six lower limb rakers in holotype with shallowly bicuspid tips. Branchiostegal rays six. Pseudobranch filaments 2–5, minute in smallest specimen.

Holotype uniformly black (paratypes faded), eye blue. Peritoneum, gill cavity and inner palate black. Outer palate and inner surface of lips pale. Adult female with ripe ova measuring 3.9–4.2 mm in diameter (not counted).

Distribution.—Known from seven specimens captured along the edge of the Peru-Chile Trench off Chile at depths of 610–1,480 m (Fig. 11).

Etymology.—From the Greek παμ (an intensifier meaning "all") and μέλας (black), a noun in apposition, alluding to the coloration of the species.

Pachycara brachycephalum (Pappenheim, 1912)

Lycodes brachycephalus Pappenheim, 1912:179–180, pl. X, fig. 3.

Austrolycichthys brachycephalus (Pappenheim). Regan, 1913: 244–245, fig. 2; Waite, 1916:15, pl. I, text fig. 2, 2A; Norman, 1938:81, 83, 84.

Pachycara brachycephalus (Pappenheim). Anderson, 1988a: 74–77, figs. 16–19.

Material Examined.—See Anderson (1988a:74–75).

Lectotype (herein designated).—ZMB 18929 (male, 169 mm); Wilhelm Land, Antarctica; GAUSS winter station; fish traps, 385 m; Deutsche Südpolar Exped., 1902.

Diagnosis.—Pelvic fins present; mediolateral lateral line originating just posterior to pectoral fin margin; ventral lateral line originating above dorsal edge of gill slit; scales absent on nape; vertebrae 23–27 + 71–86 = 95–113; D 88–107; A 72–90; P 16–18; dorsal fin origin associated with vertebrae 3–7; gill rakers 0–3 + 9–13 = 9–16; branchiostegal rays six; suborbital pores 5 + 1 (5 + 0 in one); postorbital pores 1–2; head length 14.0–19.9% SL; pectoral fin length 10.0–12.7% SL.

Distribution.—Coastal Antarctica in inner basins and on outer slope at depths of 200–1,810 m.

Discussion

So few specimens of *Pachycara* are known for most species that it is difficult to consider the evolutionary history of the genus. Phylogenetically, *Pachycara* seems to have arisen as a deep-slope sister taxon or precursor of *Lycodes*, differentiated by its reduced parasphenoid wing (apomorphy), retention of the oral valve and cephalic pores, and lack of developed mental crests (plesiomorphies; see Anderson 1984). *Thermarces* is derived with respect to *Pachycara* in four reductive characters: (1) absence of pelvic bones; (2) absence of scales; (3) absence of lateral lines; and (4) gelatinous flesh.

The present distributions of *Pachycara* species indicate two main historical biogeographic tracks: (1) North Atlantic–eastern Pacific; and (2) western South America–Antarctica (*P. brachycepha-*

lum). With only one specimen known, the origin and distribution of *P. shcherbachevi* (Indian Ocean) remains a mystery, but it appears closer to *P. bulbiceps* than the two West African species in its high vertebral count, small head, and retrograde dorsal fin origin. Recently, I reviewed the mid-Miocene tectonic history of the American tropics as it relates to the distribution of deep-sea bottom fishes (Anderson 1988a), and *Pachycara* in particular (Anderson and Peden 1988). I concluded that the closing of the Panamanian seaway to deep-demersal fishes about 7–10 million years ago did not sunder Atlantic and Pacific stocks of *P. bulbiceps* (if there were any), and that the present two populations possibly exchange genes through as yet unsampled South Pacific and South Atlantic populations (Anderson and Peden 1988). This type of distribution (Fig. 5) invites speculation on the origin and relationships of *P. sulaki,* presently known only from the western tropical Atlantic. This species expresses states of three characters that link it with southeastern Pacific forms (*P. mesoporum* and *P. rimae*) that may have phylogenetic utility: (1) possession of only five suborbital pores along the ventral ramus in some individuals; (2) dorsal fin origin retrograde, associated with vertebrae six to seven (*P. sulaki*) or eight (*P. rimae*); and (3) absence of pelvic fins in some individuals (*P. sulaki* and *P. mesoporum*). However, a phylogenetic analysis of *Pachycara* is precluded by uncertainty about the extent of distribution and the variability of many character states, particularly of the axial skeleton, dentition, cephalic pores, and the occasional lack of pelvic fins. This, in turn, produces a cautionary appraisal of the specific status of the present samples of *P. bulbiceps* (Pacific and Atlantic populations) and *P. mesoporum* (range of variation) that only future sampling may clarify.

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